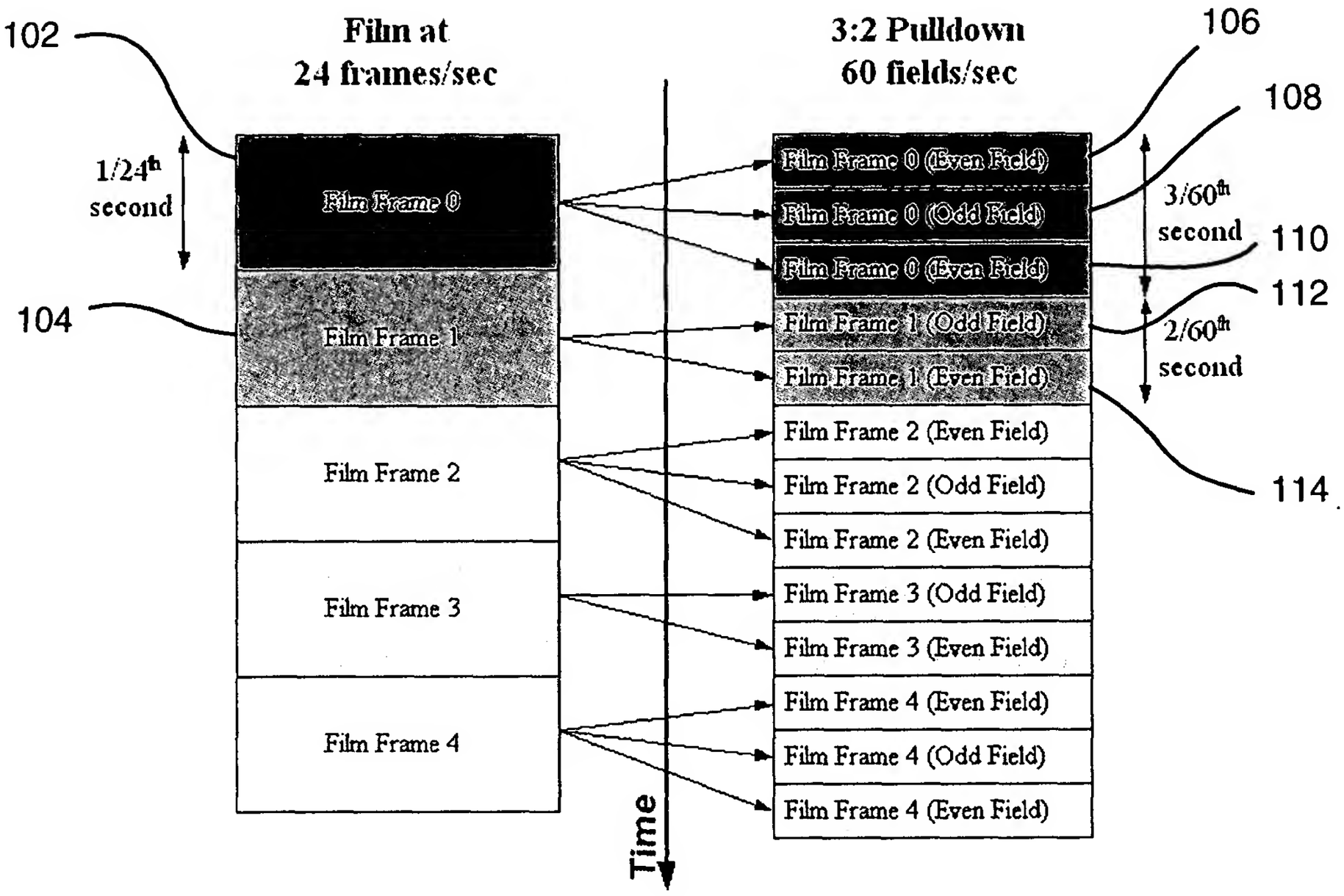

102
Film at
24 frames/sec
3:2 Pulldown
60 fields/sec
106
108
1/24th
second
Film Frame 0
Film Frame 0 (Even Field)
Film Frame 0 (Odd Field)
3/60th
second
110
Film Frame 0 (Even Field)
112
104
Film Frame 1
Film Frame 1 (Odd Field)
2/60th
second
Film Frame 1 (Even Field)
Film Frame 2
Film Frame 2 (Even Field)
114
Film Frame 2 (Odd Field)
Film Frame 2 (Even Field)
Film Frame 3
Film Frame 3 (Odd Field)
Film Frame 3 (Even Field)
Film Frame 4
Film Frame 4 (Even Field)
Film Frame 4 (Odd Field)
Film Frame 4 (Even Field)
Time

FIG. 1

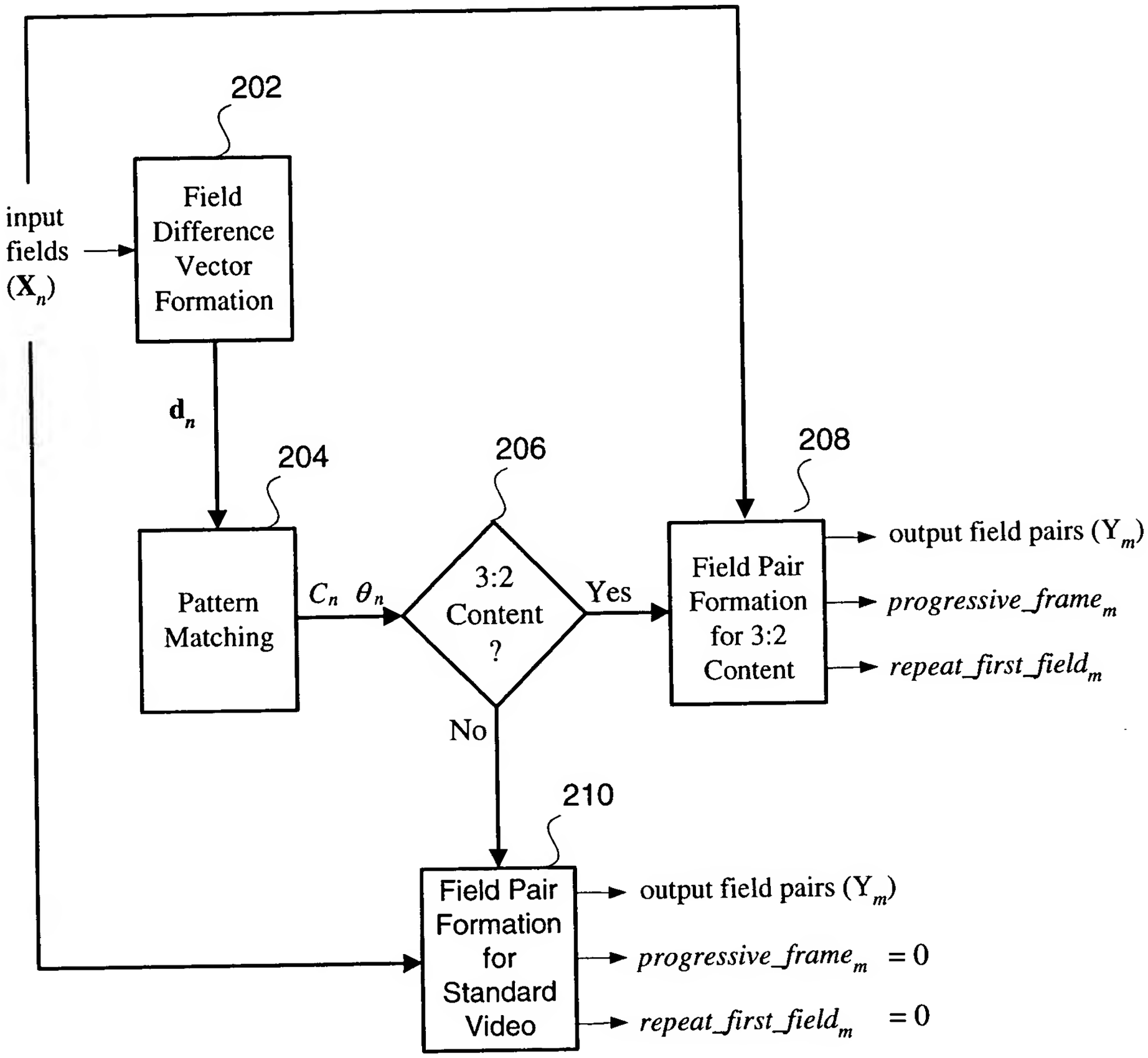

202
input fields ($\mathbf{X}_n$)
Field Difference Vector Formation
$\mathbf{d}_n$
204
Pattern Matching
C_n θ_n
206
3:2 Content ?
Yes
No
208
Field Pair Formation for 3:2 Content
output field pairs (Y_m)
$progressive\_frame_m$
$repeat\_first\_field_m$
210
Field Pair Formation for Standard Video
output field pairs (Y_m)
$progressive\_frame_m = 0$
$repeat\_first\_field_m = 0$

FIG. 2

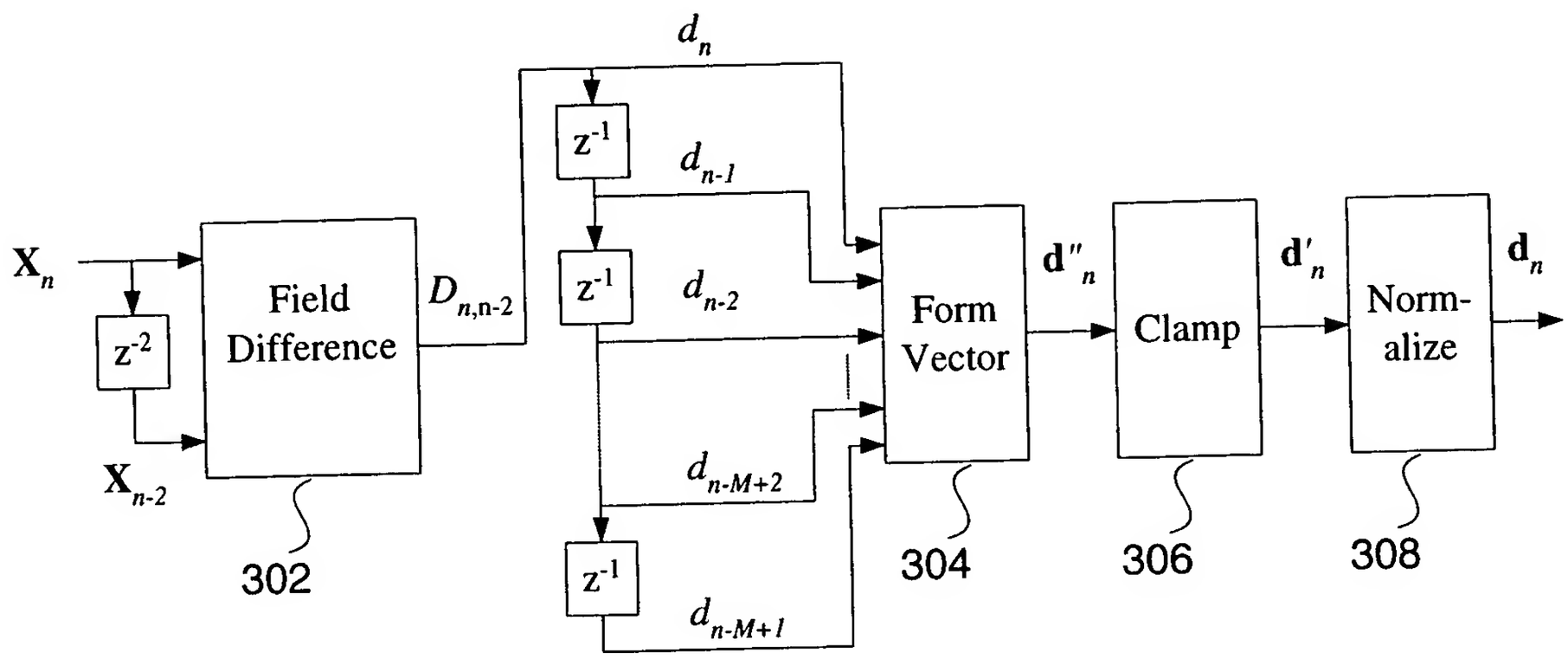

d_n
z^{-1}
d_{n-1}
z^{-1}
d_{n-2}
z^{-1}
d_{n-M+2}
z^{-1}
d_{n-M+1}
X_n
z^{-2}
X_{n-2}
Field Difference
$D_{n,n-2}$
Form Vector
d''_n
Clamp
d'_n
Norm-alize
d_n
302
304
306
308
202

FIG. 3

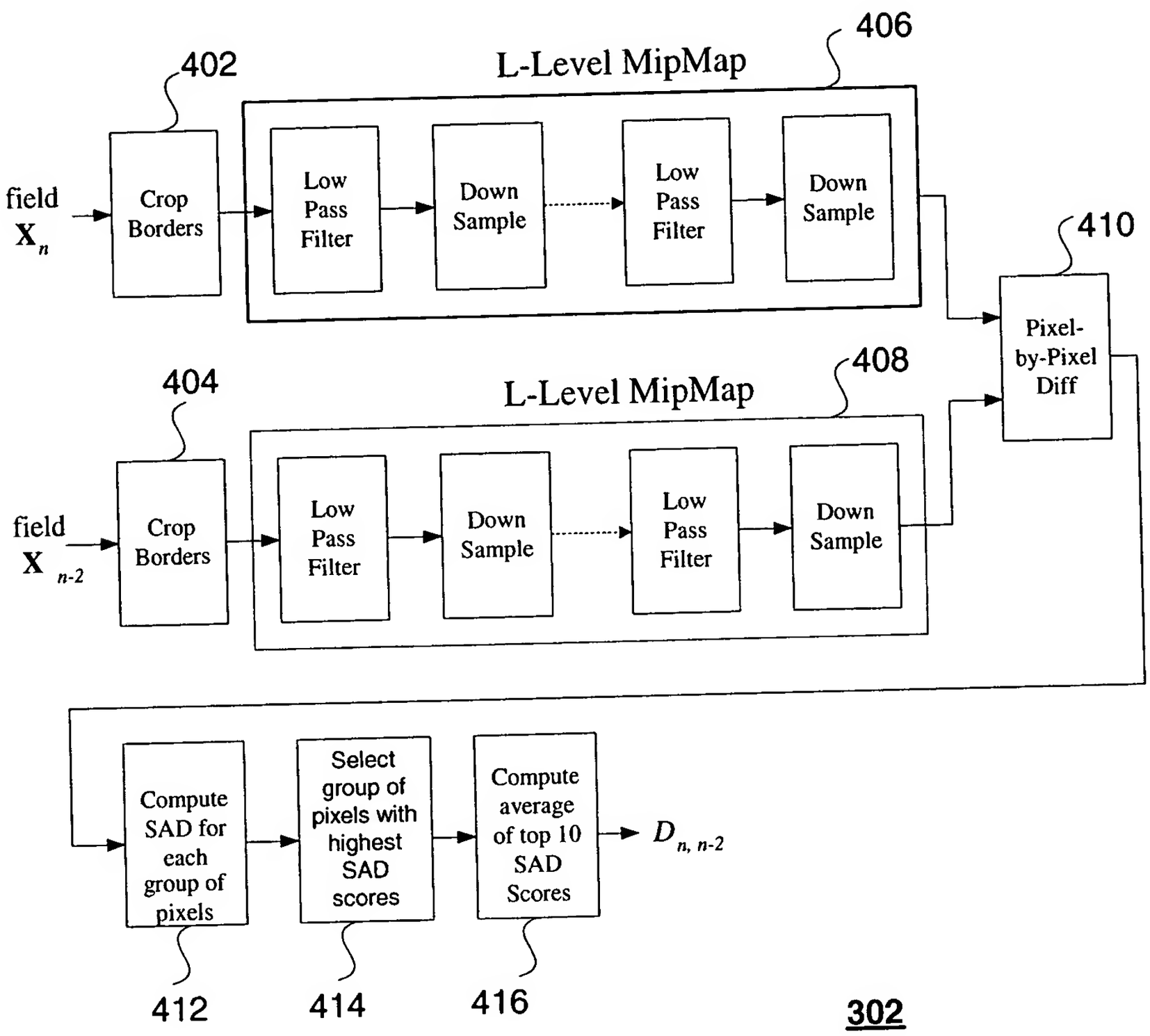
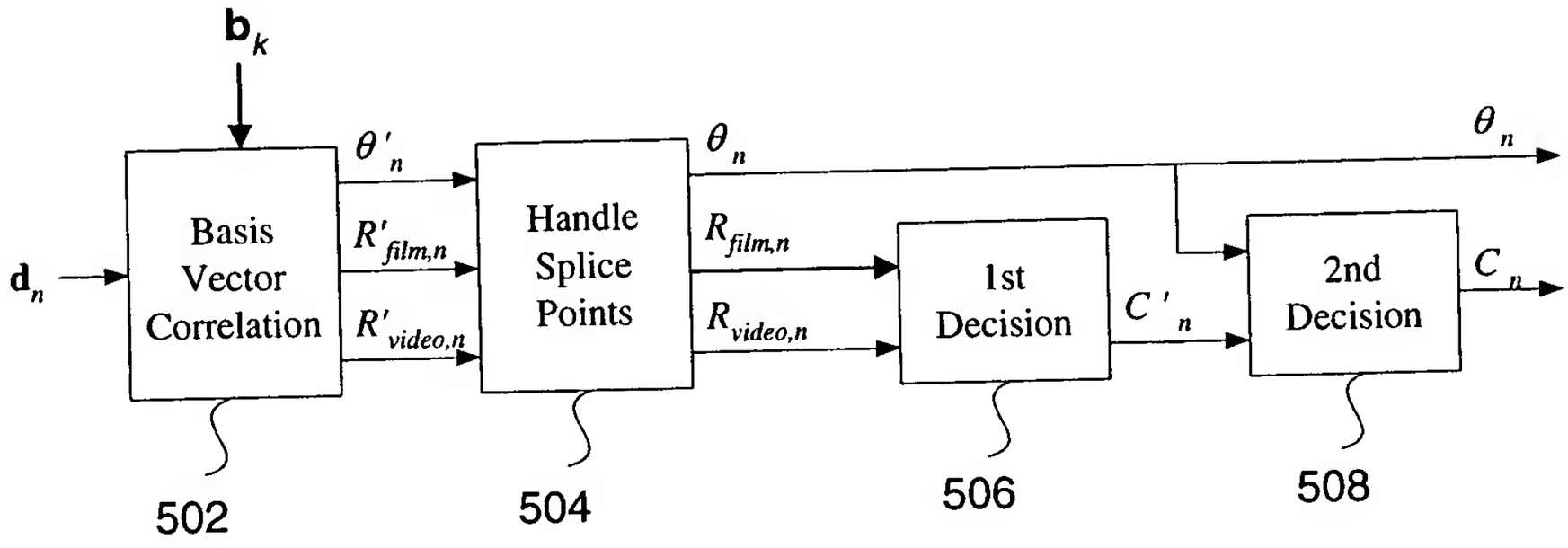

402
404
406
408
410
412
414
416
L-Level MipMap
L-Level MipMap
field X_n
field X_{n-2}
Crop Borders
Crop Borders
Low Pass Filter
Down Sample
Low Pass Filter
Down Sample
Low Pass Filter
Down Sample
Pixel-by-Pixel Diff
Compute SAD for each group of pixels
Select group of pixels with highest SAD scores
Compute average of top 10 SAD Scores
$D_{n, n-2}$
302

FIG. 4


$\mathbf{b}_k$
$\mathbf{d}_n$
Basis Vector Correlation
θ'_n
$R'_{film,n}$
$R'_{video,n}$
Handle Splice Points
θ_n
$R_{film,n}$
$R_{video,n}$
1st Decision
C'_n
2nd Decision
C_n
θ_n
502
504
506
508

204

FIG. 5

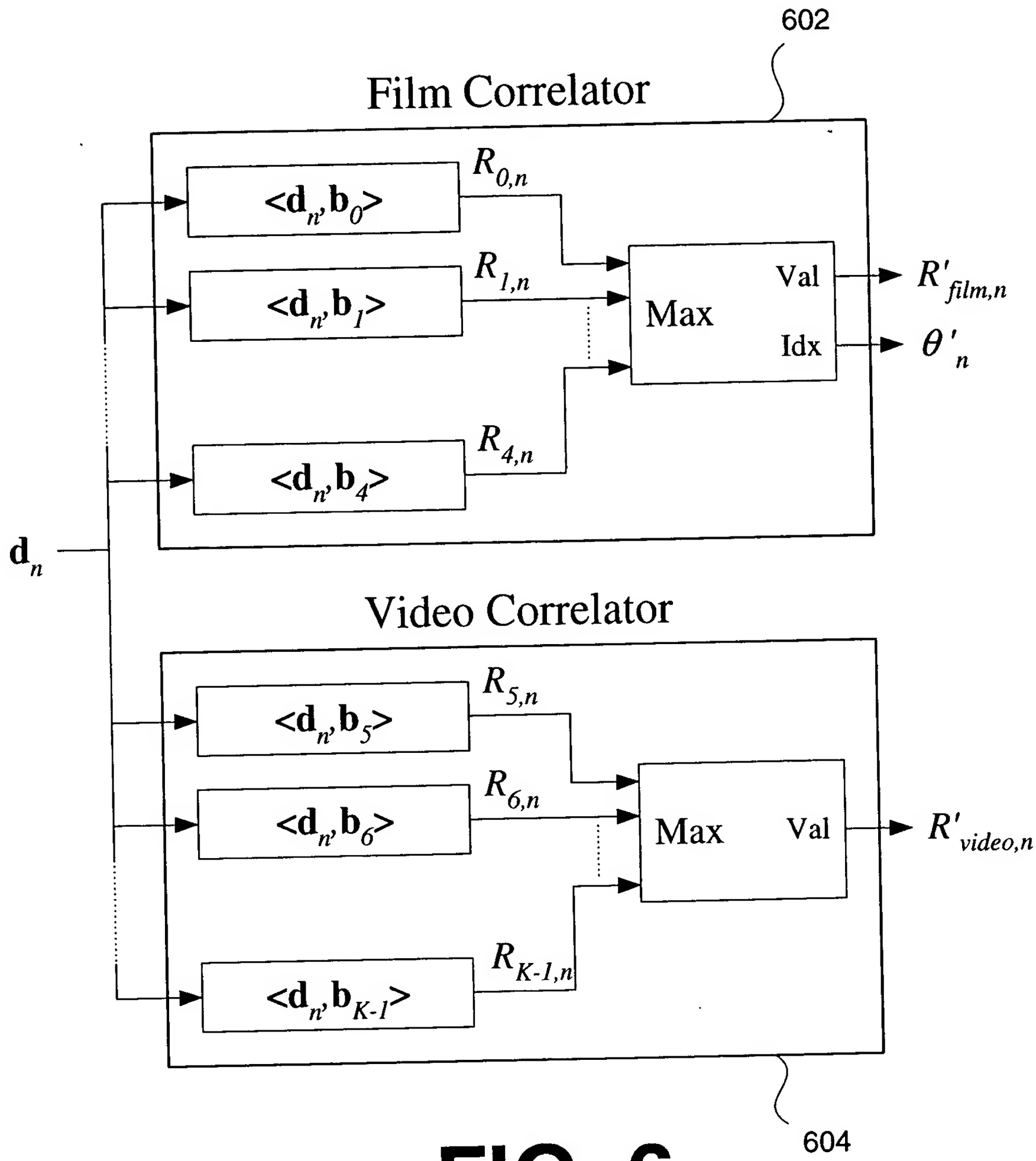
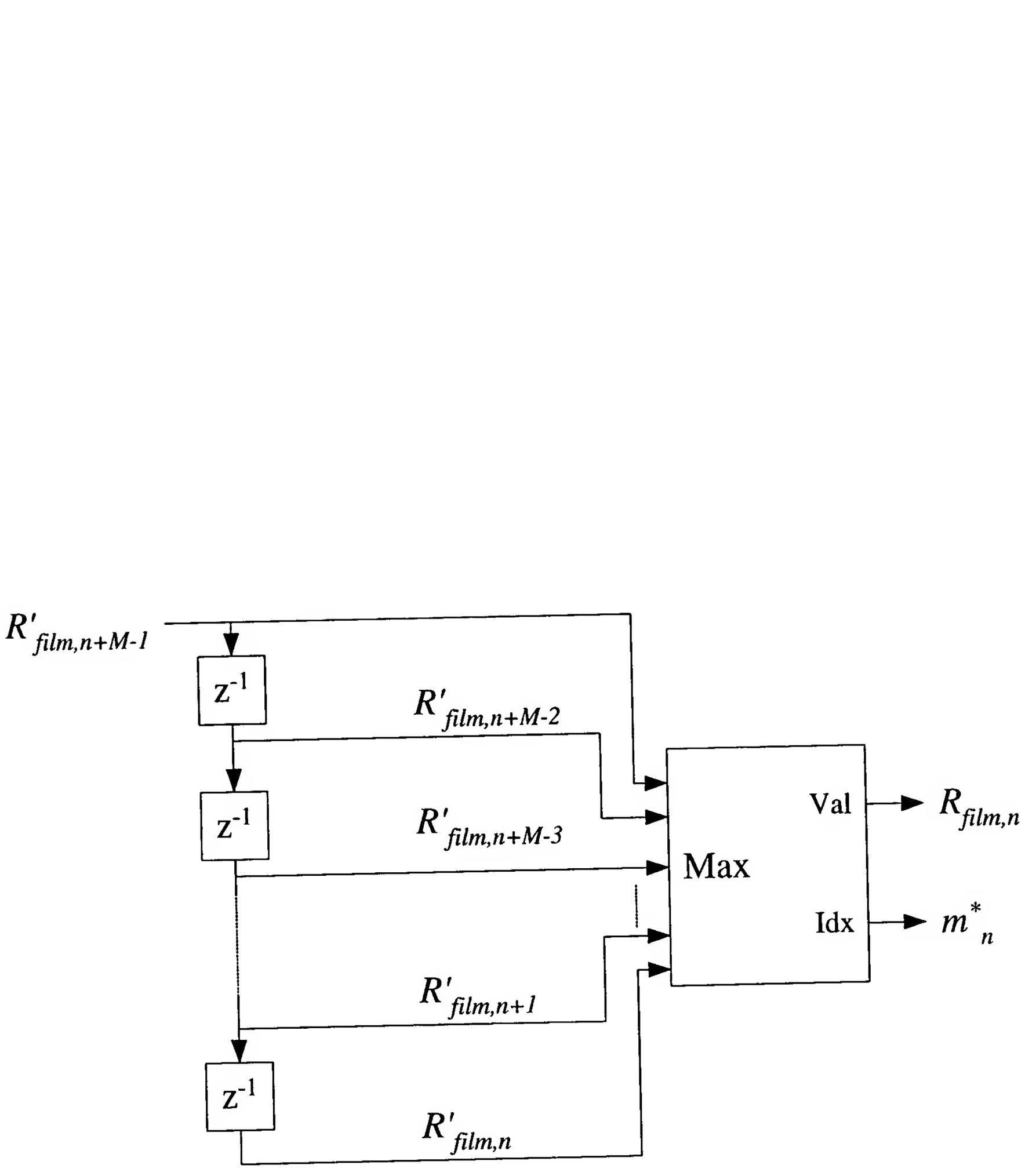
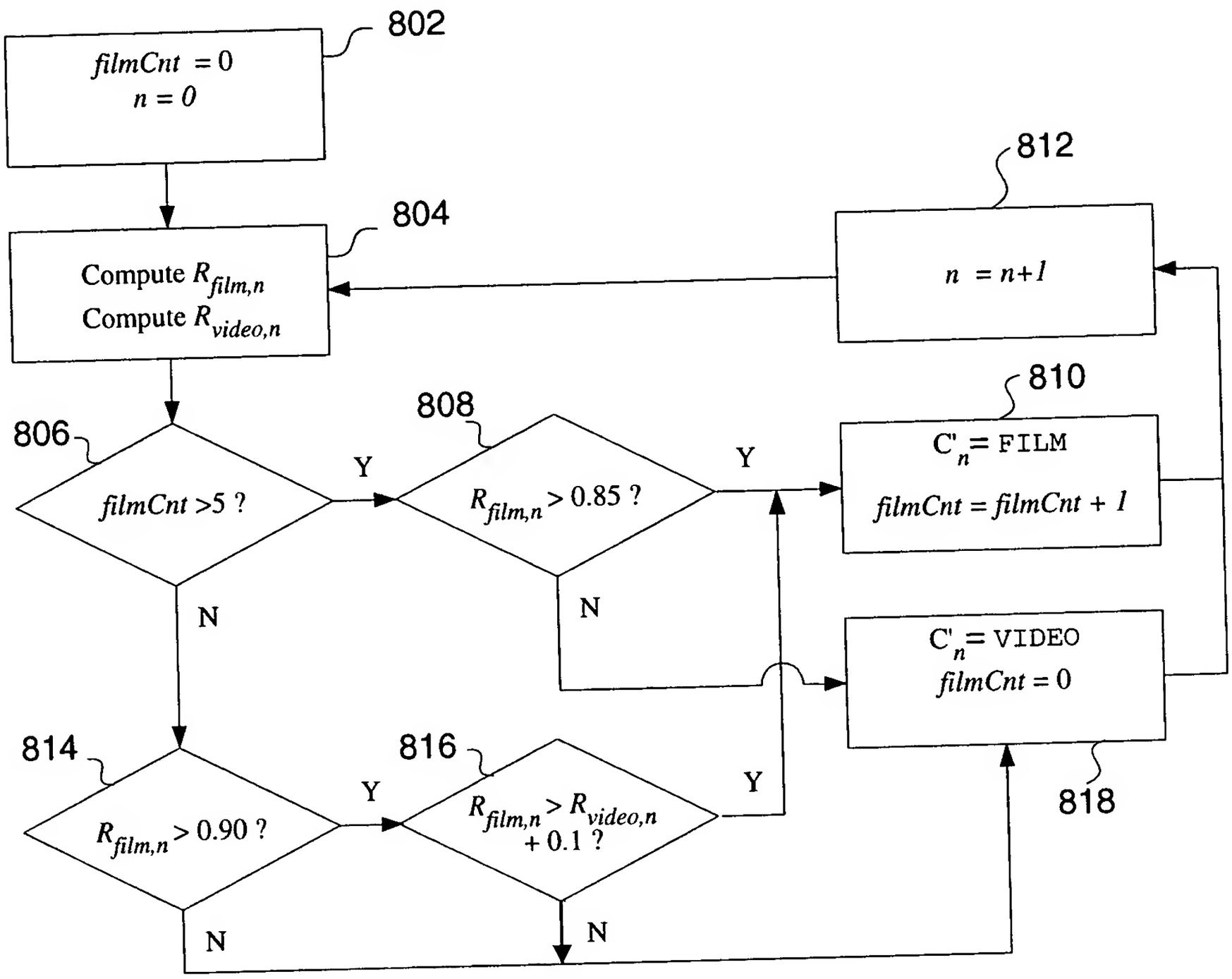

602
Film Correlator
$R_{0,n}$
$<\mathbf{d}_n,\mathbf{b}_0>$
$R_{1,n}$
$<\mathbf{d}_n,\mathbf{b}_1>$
$R_{4,n}$
$<\mathbf{d}_n,\mathbf{b}_4>$
Max
Val
Idx
$R'_{film,n}$
θ'_n
$\mathbf{d}_n$
Video Correlator
$R_{5,n}$
$<\mathbf{d}_n,\mathbf{b}_5>$
$R_{6,n}$
$<\mathbf{d}_n,\mathbf{b}_6>$
$R_{K-1,n}$
$<\mathbf{d}_n,\mathbf{b}_{K-1}>$
Max
Val
$R'_{video,n}$
604
502

FIG. 6


$R'_{film,n+M-1}$
z^{-1}
$R'_{film,n+M-2}$
z^{-1}
$R'_{film,n+M-3}$
$R'_{film,n+1}$
z^{-1}
$R'_{film,n}$
Max
Val
Idx
$R_{film,n}$
m^*_n

504

FIG. 7


802
filmCnt = 0
n = 0
804
Compute $R_{film,n}$
Compute $R_{video,n}$
806
filmCnt >5 ?
Y
N
808
$R_{film,n}$ > 0.85 ?
Y
N
810
C'n = FILM
filmCnt = filmCnt + 1
C'n = VIDEO
filmCnt = 0
812
n = n+1
814
$R_{film,n}$ > 0.90 ?
Y
N
816
$R_{film,n}$ > $R_{video,n}$ + 0.1 ?
Y
N
818

506

FIG. 8

902 904 906

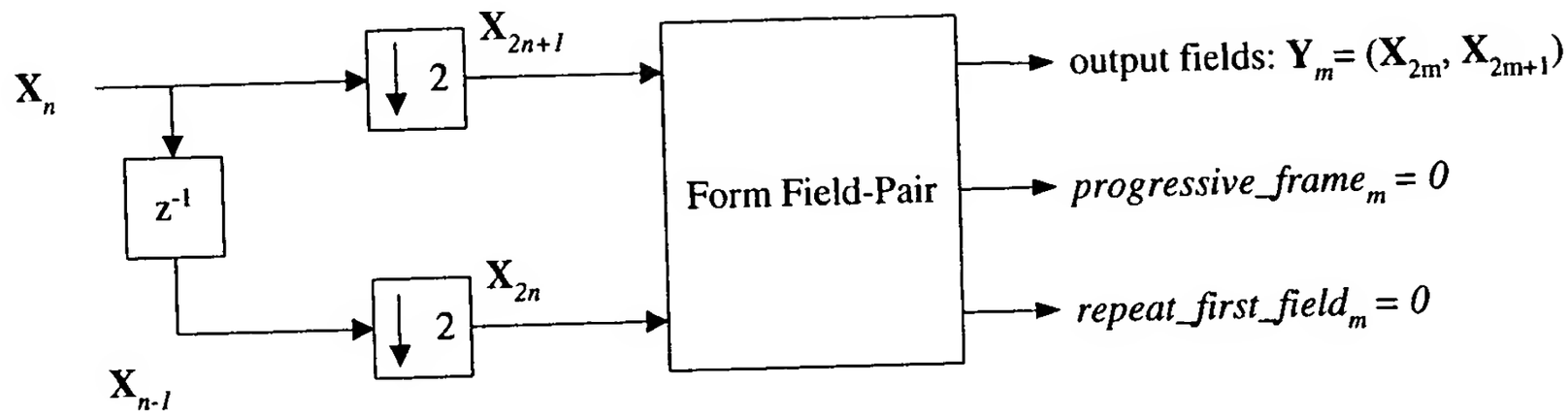
Input Field Sequence $\{X_n\}$	Observed 3:2 Phase $\{\theta_n\}$	Field-Pair Formation
n: 01234567890123456… Xn: aAbBbCcDdDeEfFfGg… Note: no splice point	----0----0----0--…	m: 0 1 2 3 4 5 6 Ym: (X0,X1)(X2,X3)(X5,X6)(X7,X8)(X0,X1)(X2,X3)(X5,X6) PF: 1 1 1 1 1 1 1 RFF: 0 1 0 1 0 1 0
n: 0123456789… Xn: aAbBbcCcDd…	----0--0--…	m: 0 1 2 3 Ym: (X0,X1)(X2,X3)(X5,X6)(X8,X9) PF: 1 1 1 1 RFF: 0 1 1 0
n: 01234567890… Xn: aAbBbCdDdEe… Xn: aAbBbCdDdEe…	----0---0--… —	m: 0 1 2 3 Ym: (X0,X1)(X2,X3)(X6,X7)(X9,X0) PF: 1 1 1 1 RFF: 0 1 1 1
n: 012345678901… Xn: aAbBbCcDdDeE… Xn: aAbBbCdEeEfF… Xn: aAbBbCcDdDeE…	----0----0--…	m: 0 1 2 3 4 Ym: (X0,X1)(X2,X3)(X5,X6)(X7,X8)(X0,X1) PF: 1 1 * 1 1 RFF: 0 1 0 1 0
n: 0123456789012… Xn: aAbBbCdDeEeFf… Xn: aAbBbCdDeEeFf… Xn: aAbBbCcDeEeFf… Xn: aAbBbCcDeEeFf…	----0-----0--…	m: 0 1 2 3 4 Ym: (X0,X1)(X2,X3)(X6,X7)(X8,X9)(X1,X2) PF: 1 1 0 1 1 RFF: 0 1 1 1 0
n: 01234567890123… Xn: aAbBbCcDdEeEfF… Xn: aAbBbCdEeFfFgG… Xn: aAbBbCcDdEeEfF… Xn: aAbBbCcDeFfFgG… Xn: aAbBbCcDdEeEfF…	----0------0--…	m: 0 1 2 3 4 5 Ym: (X0,X1)(X2,X3)(X5,X6)(X7,X8)(X9,X0)(X2,X3) PF: 1 1 * * 1 1 RFF: 0 1 0 0 1 0
n: 012345678901234… Xn: aAbBbCdDeEfFfGg… Xn: aAbBbCcDeEfFfGg… Xn: aAbBbCcDeEfFfGg… Xn: aAbBbCcDdEfFfGg…	----0-------0--…	m: 0 1 2 3 4 5 Ym: (X0,X1)(X2,X3)(X5,X6)(X8,X9)(X0,X1)(X3,X4) PF: 1 1 * 1 1 1 RFF: 0 1 0 1 1 0
n: 0123456789012345… Xn: aAbBbCcDdEeFfFgG… Xn: aAbBbCcDeFfGgGhH… Xn: aAbBbCcDdEeFfFgG…	----0--------0--…	m: 0 1 2 3 4 5 6 Ym: (X0,X1)(X2,X3)(X5,X6)(X7,X8)(X9,X0)(X1,X2)(X4,X5) PF: 1 1 1 * 1 1 1 RFF: 0 1 0 0 0 1 0
n: 01234567890123456… Xn: aAbBbCcDeEfFgGgHh… Xn: aAbBbCcDdFgGhHhIi…	----0---------0--…	m: 0 1 2 3 4 5 6 Ym: (X0,X1)(X2,X3)(X5,X6)(X7,X8)(X0,X1)(X2,X3)(X5,X6) PF: 1 1 1 * * 1 1 RFF: 0 1 0 0 1 1 0
n: 012345678901234567… Xn: aAbBbCcDdFfGgHhHiI…	----0----------0--…	m: 0 1 2 3 4 5 6 7 Ym: (X0,X1)(X2,X3)(X5,X6)(X7,X8)(X9,X0)(X1,X2)(X3,X4)(X6,X7) PF: 1 1 1 1 1 1 1 1 RFF: 0 1 0 0 0 0 1 0

Key

Symbol	Meaning
Xn	Input field sequence with field index n.
Ym	Output field-pair sequence with field-pair index m.
(Xj,Xk)	A field pair consisting of field Xj and Xk.
PF	The *progressive_frame* flag
RFF	The *repeat_first_field* flag.
*	Use the frame difference ($D_{n, n-1}$) to set the *progressive_frame* flag to 1 if the frame difference is small.
0	A telecine phase of zero.
-	A non-zero telecine phase.
aAbBb	First field sequence. Lower case and upper case letters of the same letter correspond to even and odd fields of a single film frame.
gGgHh	Second field sequence. Lower case and upper case letters of the same letter correspond to even and odd fields of a single film frame.

FIG. 9

208


X_n
2
X_{2n+1}
z^{-1}
2
X_{2n}
X_{n-1}
Form Field-Pair
output fields: $Y_m = (X_{2m}, X_{2m+1})$
$progressive\_frame_m = 0$
$repeat\_first\_field_m = 0$

210

FIG. 10

```
Init:

n = 1;
m = 0;

Start:

 Get C[n] and θ[n] from Pattern Matching Engine;
availableFields = m - n;

if (availableFields >= 2) {
    fieldOut0 = X[n];
    fieldOut1 = X[n-1];
    repeat_first_field = false;
    progressive_frame = false;

    if (C[n] == VIDEO) {
        m = m + 2;
    }
    else {
        if (availableFields == 3) {
            repeat_first_field = true;
            progressive_frame = true;

            if( θ[n-2] !=0 AND θ[n+1] != 0 AND θ[n+3] != 0) {
                fieldOut0 = X[n-1];
                fieldOut1 = X[n-2];
            }

            m = m + 3;
        }
        if (availableFields == 2) {
            if( θ[n-1] !=0 AND θ[n+1] != 0 AND θ[n+2] !=0 AND θ[n+4] != 0) {
                progressive_frame = true;
                m = m + 2;
            }
            else {
                n = n + 1;
                goto Start;
            }
        }
        if (C[n] == FILM_IN_TRANSITION) {
           if ((D(field0, field1) > threshold) OR ( θ[n-3] == 0 AND θ[n+3] == 0)) {
                progressive_frame = false;
            }

        Output( fieldOut0, fieldOut1, repeat_first_field, progressive_frame );
    }
}

n = n + 1;
goto Start;
```

FIG. 11